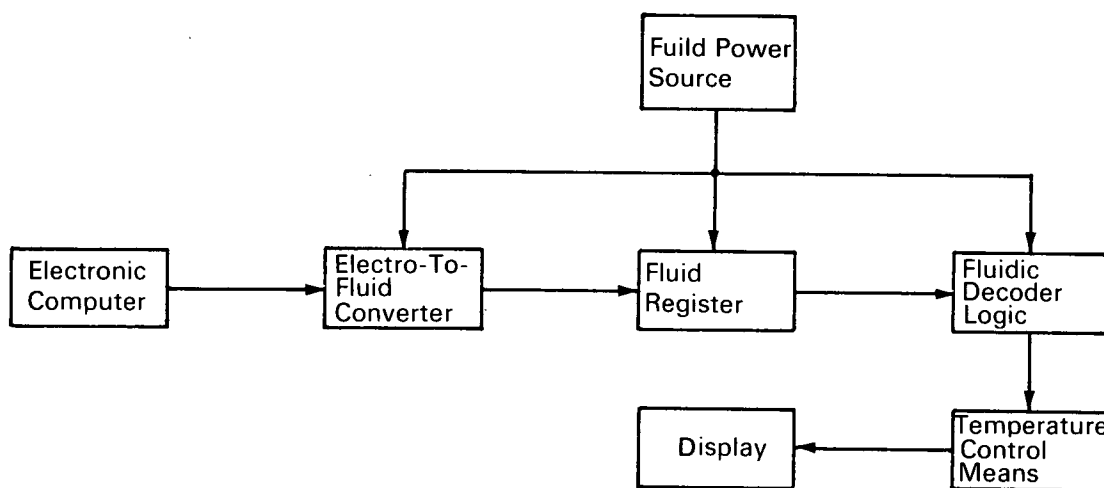


# NASA TECH BRIEF



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## Fluidic-Thermochromic Display Device



### The problem:

Fluidic logic, because of its high reliability and potentially low cost, offers interesting possibilities for the generation of an interface between sensors or computers and displays, but the use of moving parts in a display immediately offsets the reliability inherent in the fluidics. Alternatively, the use of fluidic elements to control any sort of self-emitting display poses readability problems in airborne vehicles when direct sunlight impinges on the display.

### The solution:

A concept has been developed to use the fluidics for temperature control of thermochromic materials; i.e. those which change color upon exposure to heat and revert to their original color when cooled. This not only eliminates requirements for any moving parts, but also provides a display readily observable under high ambient illumination levels, since the color change in the materials is due to differential reflection rather than to light emission.

### How it's done:

The figure shows a model of a fluidic decoder and display device built as part of a NASA-sponsored study contract on fluidic displays.

The function of the electro-to-fluid converter is to translate the incoming electrical signals into pneumatic signals of sufficient power to operate the fluidic logic elements in the remaining part of the decoder and display device. The converter operates on typical small computer output signals, e.g. 20-volt, 1 milli-ampere square wave of 15-millisecond duration. The amount of pneumatic power required to obtain switching flow for the miniature fluidic elements is small. These low-power requirements make it possible to consider several concepts of electrofluid interface devices. The most promising device is a pneumatic flapper valve in which a piezoelectric crystal is used to open and close a small orifice. The pressure changes obtainable with this miniature device are sufficient to switch a miniature fluidic gate. The latest model of

(continued overleaf)

this device has been operated with an input as low as 10 volts dc. Because the amount of power required to switch the fluidic elements is extremely small, the necessary movement of the piezoelectric crystal can be obtained without using electronic oscillators and step-up transformers, a significant improvement over prior practice.

The function of the fluid register is to store the binary information supplied by the computer via the electrofluid interface, for further processing. The register consists of fluidic flip-flops that perform the function of a memory. The register input is obtained from two parallel pneumatic inputs: one input is a clock pulse; the second input contains the binary information. The register is actually a 16-bit fluidic shift register.

The decoder logic module transforms the binary information into corresponding signals to the readouts. The decoder logic gates are formed in sheets of 0.004-inch-thick copper by a chemical etching process. Each etched plane contains two logic gates. The complete decoding logic block is formed by diffusion bonding of interconnecting planes and element planes into one integrated assembly measuring approximately 1.2 by 1.0 by 0.4 inches. The integrated bonded assembly is free from leakage paths, which are common causes of malfunctions in conventional fluidic circuitry, and the small interconnections have resonant frequencies far above the response time of even the comparatively fast miniature fluid gates, thus eliminating another problem so often experienced with larger fluidic logic element assemblies.

Considerable difference in time cycles can be obtained by changing some of the dimensions of internal channels, etc., since the obtainable minimum time intervals between updates are largely dependent on the thermal capacity of the immediate environment of the thermochromic material.

#### **Notes:**

1. The materials on which this device is based have been developed under contract by NASA and reported in NASA publications CR-80016 and CR-86031 available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151, price \$3.00 (microfiche \$0.65)
2. Inquiries concerning this invention may be directed to:

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Reference: B68-10350

#### **Patent status:**

This invention is owned by NASA, and a patent application has been filed. Royalty-free, nonexclusive licenses for its commercial use will be granted by NASA. Inquiries concerning license rights should be made to NASA, Code GP, Washington, D. C. 20546.

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